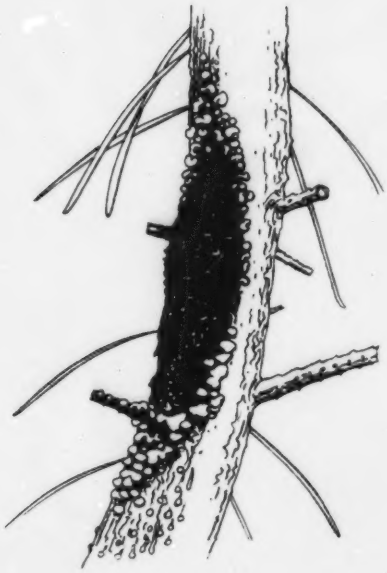

FOREST HEALTH NETWORK

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Report on Forest Pest Conditions

Queen Charlotte Islands, British Columbia, 2001

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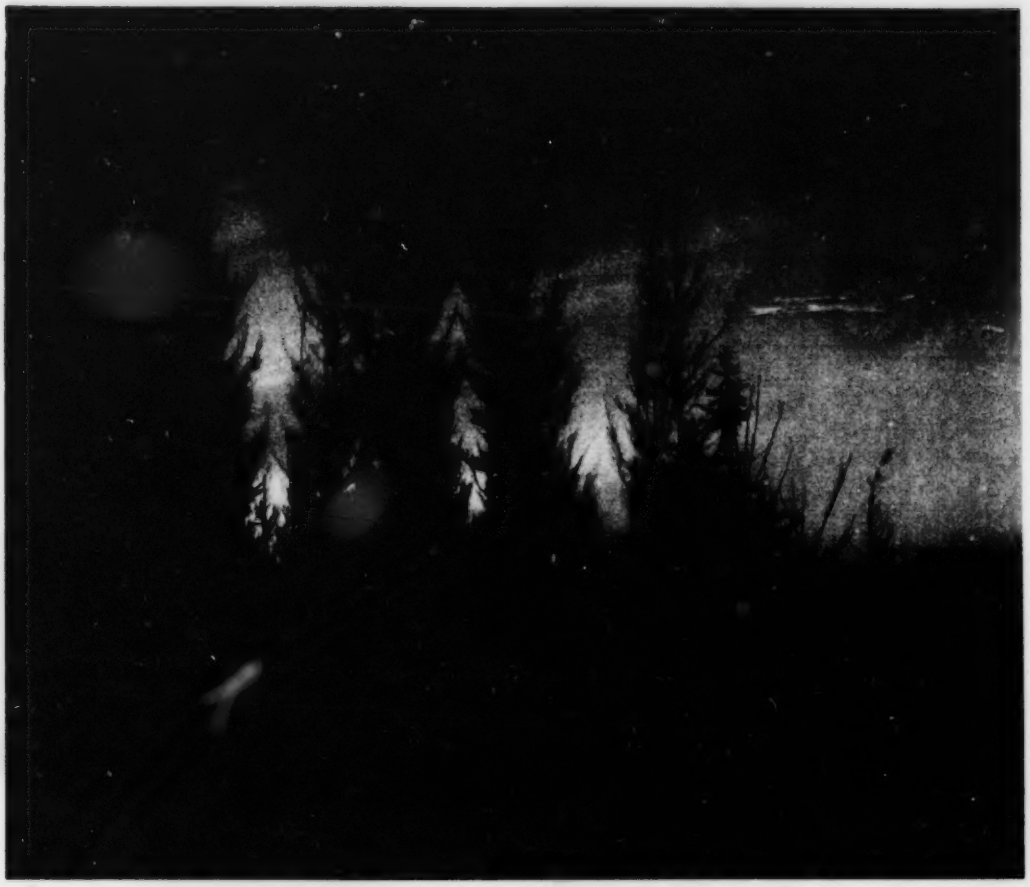


Mortality to juvenile western hemlock caused by two consecutive years defoliation by blackheaded budworm, Moresby Island, Queen Charlotte Islands.

TABLE OF CONTENTS

INTRODUCTION 1

GENERAL SURVEYS 1

INSECT DEFOLIATORS 2
- Ground surveys 2
- Aerial surveys 2
- Assessments and recovery in regenerating western hemlock 4

IMPACT 8
- Damage to associated conifers 8
- Egg sampling and defoliation predictions 8
- Plans for 2002 9

REFERENCES 9

Figure 1. Western blackheaded budworm and hemlock sawfly defoliation, and damage appraisal sites, Queen Charlotte Islands, 2001.

Figure 2. Cumulative mean % whole-tree defoliation, 1998 - 2001, caused by blackheaded budworm, in spaced and unspaced stands, at ten damage appraisal sites, Moresby Island, Queen Charlotte Islands.

Figure 3. Mean proportion of live crown 100% defoliated by blackheaded budworm, in spaced and unspaced stands, 1998 – 2001, at ten damage appraisal sites, Moresby Island, Queen Charlotte Islands.

INTRODUCTION

A Memorandum of Understanding (MOU) between the British Columbia Ministry of Forests (MoF) and Natural Resources Canada-Canadian Forest Service (CFS) to report on forest health and pest conditions on the Queen Charlotte Islands was initiated in 1991. Until 1995, annual aerial and ground surveys were carried out by the Forest Insect and Disease Survey (FIDS) of the CFS. Since 1996, surveys have been a carried out by the Forest Health Unit (CFS). In 1998, a collaborative research project led by researchers from the CFS was initiated in response to expansion of an outbreak of the western blackheaded budworm, *Acleris gloverana*, and associated hemlock sawfly, *Neodiprion tsugae*. The required field studies have been funded by the South Moresby Forest Replacement Account (SMFRA) and the CFS.

This report includes the results of ground and aerial surveys carried out in 2001. Also included are the fourth year of measurements on study plots designed to estimate the impact of various levels of defoliation on regenerating stands of different stocking densities of western hemlock, *Tsuga heterophylla*.

GENERAL SURVEYS

Surveys focussed on known or potential pest problems. Ground surveys were carried out by R. Garbutt between August 1 and 8th, followed by aerial surveys in the first week of September. Ground surveys concentrated on areas of Moresby and Graham Island that were accessible by road. In addition to the blackheaded budworm and hemlock sawfly, pests of particular interest during the surveys included; the Cooley spruce gall adelgid, *Adelges cooleyi*, the spruce aphid, *Elatobium abietinum*, and the spruce weevil, *Pissodes strobi*. Visible defoliation, caused by both the blackheaded budworm and the hemlock sawfly, as well as grey tops and dead trees resulting from previous feeding by the blackheaded budworm, were mapped from the air on 1:250 000 scale topographic maps. These sketch maps were then digitized using ArcInfo GIS, saved in Lambert conformal conic projection, and stored in the Pacific Forestry Centre's GIS database.

Cooley spruce gall adelgid was found for the 12th consecutive year on Douglas-fir, *Pseudotsugae menziesii*, near Queen Charlotte City. For the first time since 1993, three galls caused by the adelgid were found on a single mature Sitka spruce, *Picea sitchensis*, growing near the planted Douglas-fir. Galls had previously been found on Sitka spruce adjacent to planted Douglas-fir, near Sandspit, from 1991 to 1993. Those infested spruce, as well as the planted Douglas-fir near them, were removed and destroyed. Subsequent surveys found no evidence of infested spruce in the area. There have been no other recorded infestations on Sitka spruce until this year. The presence of galls on spruce adjacent to planted Douglas-fir highlights the potential for spruce pests to become established on the Queen Charlotte Islands through planting of non-native tree species with their attendant pests. Complete removal of both the planted Douglas-fir, as well as the infested spruce, is recommended to remove the potential for further infestations.

Despite the previous mild winter, there was little evidence of recent spruce aphid, *Elatobium abietinum*, damage on Sitka spruce where chronic damage has occurred in the past, most notably between Sandspit and Alliford Bay on Moresby Island and between Skidegate and Tlell on Graham Island. Surveys in several locations on both Graham and Moresby Islands failed to find evidence of the spruce weevil, *Pissodes strobi*, on Sitka spruce. This insect has caused significant damage to spruce regeneration in other parts of British Columbia and could cause similar damage on the Queen Charlotte Islands if it was introduced.

INSECT DEFOLIATORS

The western blackheaded budworm and hemlock sawfly are native insects that periodically cause extensive defoliation of western hemlock (Koot 1991). The current infestation is the third recorded outbreak of these defoliators in as many decades on the Queen Charlotte Islands. The blackheaded budworm feeds preferentially on current-year foliage, but when numerous, will feed on older foliage (Koot, 1991). The hemlock sawfly feeds primarily on older foliage. In combination, these insects can totally defoliate trees in one year. Historically, outbreaks have been observed mostly in mature forests. Recent outbreaks, particularly this current infestation, have caused dramatic defoliation in juvenile stands of western hemlock.

Ground surveys

Ground surveys for the larval and pupal stages of blackheaded budworm and hemlock sawfly were carried out in early August. Insect populations were sampled using the standard "three-tree beating" method. Tree beatings helped to confirm the identity and relative abundance of the two insect species that have caused visible defoliation mapped during aerial surveys in previous years.

Due to abnormally cool wet summer weather, larval development was retarded, and in the first week of August most individuals of both species were still in their early to mid-larval stages. Normally by early August the blackheaded budworm has finished feeding and the sawfly nearly so. In limited beating samples on Graham Island, hemlock sawfly populations outnumbered blackheaded budworm by 50 to 1, with budworm only showing up in significant numbers in the central portions of Graham Island. Sawfly populations, though outnumbering budworm, were variable but generally low. This is the first time during this outbreak that the relative abundance of sawflies has been greater than that of the blackheaded budworm.

Aerial Surveys

Total area of current defoliation mapped during aerial surveys in 2001 was about 335 ha: 200 ha of light and 50 ha of moderate budworm defoliation just north of Juskatla Inlet; and 85 ha of light defoliation, just off the Mamin main southwest of Juskatla Inlet, attributed to hemlock sawfly. This is a dramatic reduction from the 31 400 ha recorded in 2000 (Turnquist et al. 2000). It is the second year of declining area (Table 1) and very likely signals the end of the current outbreak. In addition to the current defoliation, about 1500 ha of grey (dead trees and/or extensive dead tops) was mapped this year. The grey, mainly recorded in juvenile stands, is a result of severe defoliation from 1998 to 2000.

Table 1. Year, area of defoliation by intensity, and total area defoliated by the blackheaded budworm and hemlock sawflies, Queen Charlotte Islands, 1996-2001.

	1996 [1]	1997 [2]	1998 [3]	1999 [3]	2000 [3]	2001
Light	8100	15000	30760	37630	14800	285
Moderate	1180	14800	4280	11220	7120	50
Severe	180	7200	2260	6200	9480	0
Total	9460	37000	37300	55050	31400	335

[1] Vallentgoed, 1996; [2] Koot, 1997; [3] Turnquist et al. 1998, 1999, 2000.

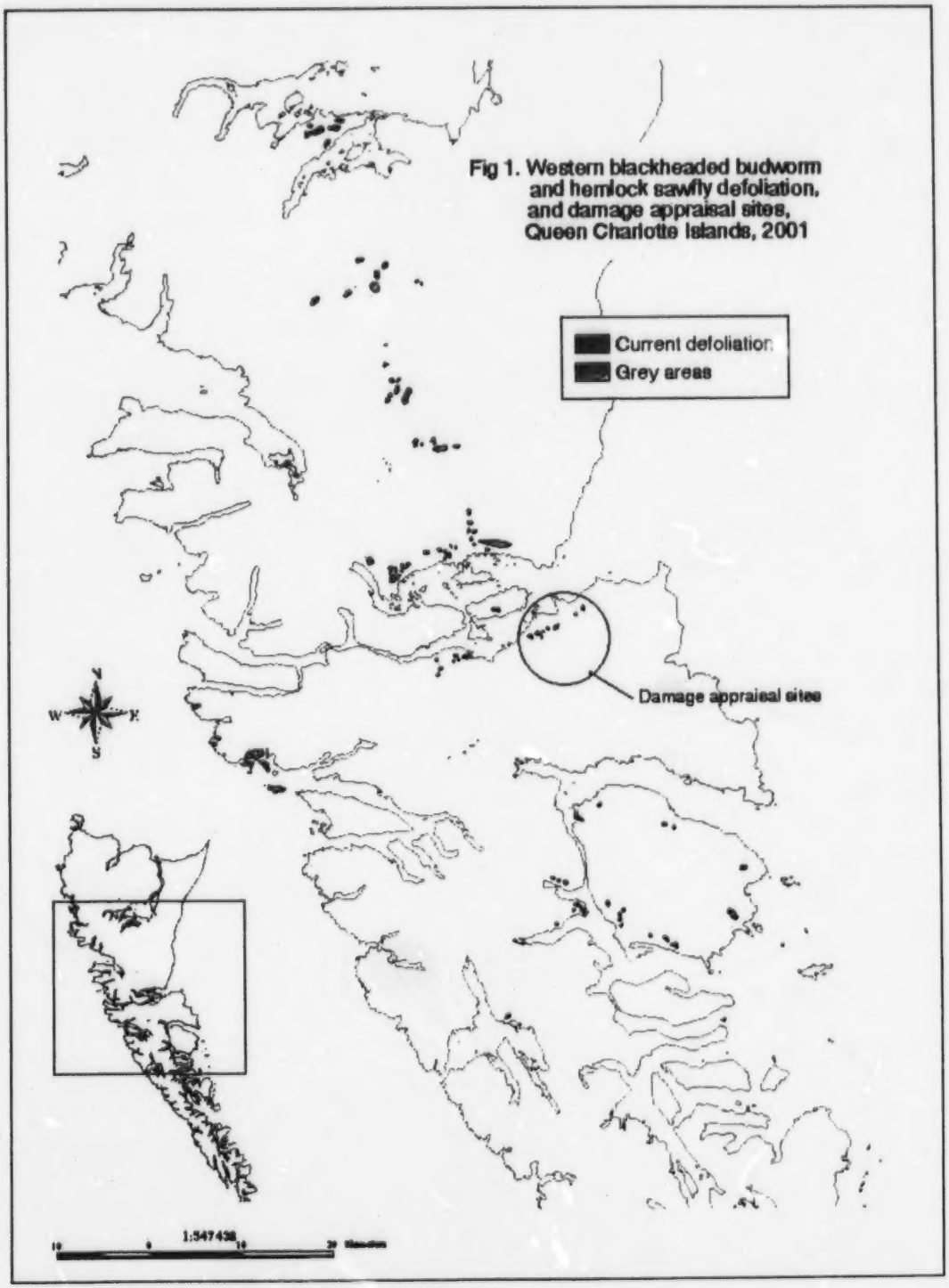


Fig 1. Western blackheaded budworm and hemlock sawfly defoliation, and damage appraisal sites, Queen Charlotte Islands, 2001

As in the two previous outbreaks in the 1970's and 1980's, defoliation in the current outbreak was first seen on southern Moresby archipelago, and in subsequent years, progressed northward. From 1997 to 2000, defoliation was recorded on both Islands, with the total area on Graham Island increasing each year. In 2001, the only current defoliation recorded was on Graham Island at the northern edge of the area of defoliation mapped in 2000 (Fig 1). For the second consecutive year, no defoliation was recorded in Gwaii Haanas National Park Reserve/Haida Heritage Site.

Defoliation attributed to the blackheaded budworm was mapped, on Graham Island, in a few small patches north of Mt. Begbie on the peninsula between Shannon Bay and Juskatla Inlet. Another small patch was mapped north of Marie Lake. Defoliation attributed to hemlock sawfly was mapped in three small areas near Mamin Creek, east of Marie lake. Grey trees were mapped, on Graham Island, in patches from Marie Lake to Queen Charlotte City. The heaviest concentrations were between Phantom and King Creeks, near Survey and Brett Creeks, and from Queen Charlotte City to Skowkona Creek. Grey trees were also recorded above Queen Charlotte City and west to Long Inlet, near Tarundl, Outlook and Slatechuck Creeks. On the Moresby archipelago, grey areas were mapped above Alliford Bay near Sachs Creek, between the Deena River and Skidegate Channel, on both the north and south sides of Louise Island, near Lagoon Inlet opposite Louise Island, and one small area on the west facing side of Tasu Sound. No grey areas were mapped south of Tasu Sound and Talunkwan Island, or in the Gwaii Haanas National Park Reserve/Haida Heritage Site. All of the areas where grey trees were recorded this year were in regenerating stands where one to two years of severe defoliation, caused by the blackheaded budworm, were mapped between 1998 and 2000.

Assessments and recovery in regenerating western hemlock

In 1998 a project was initiated to examine the impact of defoliation on regenerating western hemlock. Ten sites consisting of five plots/site with 10 trees/plot for a total of 50 trees/site were established in 15-25 year old stands of regenerating hemlock near Alliford Bay on Moresby Island (Turnquist et al. 1998). In 2001, as in the three previous years, defoliation estimates (which this year became estimates of recovery) were recorded by crown thirds, and length of top stripping was recorded. Budworm populations in the area of the plots collapsed in 2000, and with no evidence of feeding for a second consecutive year, branch samples for egg densities, were not collected. Damage and/or recovery were also estimated at two locations on Graham Island where insect populations and damage have been observed since 1999.

In early 2001, the study of damage appraisal was expanded with the co-operation of Weyerhaeuser and Western Forest Products. Thirty, randomly located plots, stratified by age and silvicultural treatment (spacing), were established on Graham and Moresby Islands. Defoliation in 2000 was recorded and branch samples for estimating egg densities collected from a subset of these sites. A preliminary report on defoliation in these plots was prepared and forwarded to Weyerhaeuser and Western Forest Products. The results of the egg density estimates are included in this report.

For the second consecutive year, the cumulative mean foliar loss was reduced from the maximum observed in 1999 at all of the 10 sites near Alliford Bay indicating continuing recovery of the crowns of most trees. Recovery was evident throughout the crown (Table 2, Fig. 2) but was greatest in the lower crown third. The middle and particularly the upper crown thirds, while recovering from levels observed in 2000 and earlier, still showed the effects of previous feeding with thin crowns and, in some cases, dead tops.

Dead tops were observed in 8 of the 10 sites in 2001, although the mean length of top-stripping and the proportion of live crown 100% defoliated was reduced from observations in 2000 in most sites (Table 3, Fig. 3). This indicates some recovery within the length of previously-stripped crown. However, the percentage of trees with dead tops did not change significantly in most eight sites (Table 3). The inability of these trees to fully refoliate 2 years after the collapse of budworm populations is indicative of the vulnerability of these trees to severe and repeated defoliation.

Crown recovery was also noted in study sites near Phantom and King Creeks on Graham Island. The King Creek site, severely defoliated in 2000, still had an overall level of whole tree defoliation exceeding 75% for the second consecutive year (Table 2). Tree mortality and top kill was observed at this site. No mortality, and little top kill was recorded at Phantom Creek.

The apparent trend of greater overall damage to trees in spaced stands noted in earlier reports (Turnquist *et al.* 1998, 1999, 2000) carried over in our estimates of recovery in 2001; unspaced stands had the best overall recovery (Fig. 2, 3). Dead tops were recorded in only three of the five unspaced stands, while dead tops were present in all the spaced stands (Table 3).

Table 2. Stand location, opening number, treatment and cumulative mean % whole tree defoliation caused by blackheaded budworm, Queen Charlotte Islands, 1998-2001.

Location	Stand Opening No.	Treatment	Cumulative mean % defoliation[1] Whole tree 1998	1999	2000	2001
Alliford Bay	J1185	Spaced	75	87	72	38
	J1105	Spaced	62	71	56	23
	J1065	Spaced	58	94	91	76
	57-B	Spaced	26	29	26	8
	J1108	Spaced	13	47	30	6
	J1137/1054		59	73	61	25
	J1041		17	60	54	17
	J1107		7	19	8	1
	J1109		37	47	37	8
	57-A		23	29	18	4
Phantom Cr.	-	Spaced	0	28	54	24
King Cr.	-	Spaced	0	17	83	78

[1] Alliford Bay site based on 50 trees/site, Phantom Cr. based on 59, King Cr. based on 10 trees/site

Table 3. Stand opening number, treatment, average (1998) tree height, percent of trees with stripped top and mean length of stripped top, caused by blackheaded budworm, at ten damage appraisal sites, Moresby Island, Queen Charlotte Islands, 1998-2001.

Stand Opening No.	treatment	Ave. tree height (m)[1] 1998	Percent of trees with stripped top 1998	1999	2000	2001	Mean length (m) of top-stripping 1998	1999	2000	2001
J1185	Spaced	11.4	90	70	72	70	4.5	4.5	2.5	1.7
J1105	Spaced	6.8	44	56	46	50	1.5	1.6	0.8	0.6
J1065	Spaced	7.2	30	88	82	82	1.0	5.6	4.3	4.3
57-B	Spaced	7.5	4	10	10	10	0.1	0.2	0.2	0.2
J1108	Spaced	7.9	0	14	6	6	0	0.5	0.1	0.1
J1137/1054		8.7	40	66	50	50	1.8	3.2	1.4	0.9
J1041		6.0	0	80	40	38	0	2.6	0.7	0.4
J1107		6.8	0	0	0	0	0	0	0	0
J1109		6.7	0	8	6	4	0	0.3	0.1	0.04
57-A		6.5	0	0	0	0	0	0	0	0

[1] All observations in table 3 are based on 50 trees/site

Fig. 2. Cumulative mean % defoliation, caused by blackheaded budworm, in spaced and unspaced stands, 1998-2001, at ten damage appraisal sites, Moresby Island, Queen Charlotte Islands.

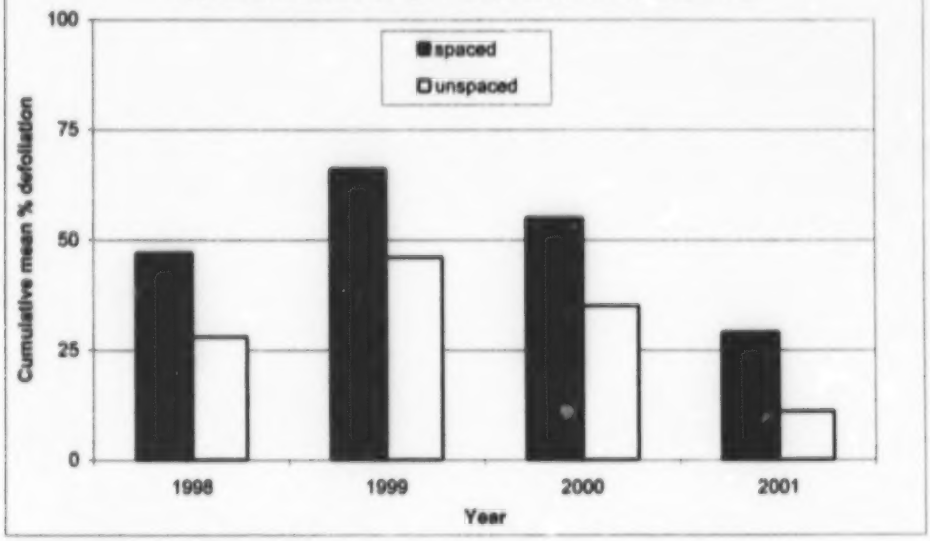
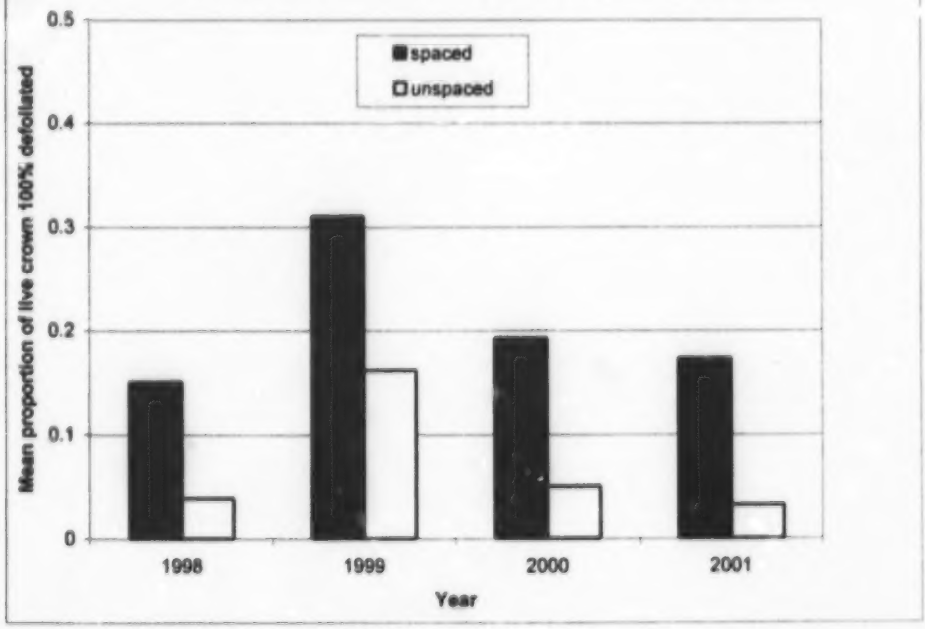


Fig. 3. Mean proportion of live crown 100% defoliated by blackheaded budworm, in spaced and unspaced stands, 1998-2001, at ten damage appraisal sites, Moresby Island, Queen Charlotte Islands.



IMPACT

Despite no defoliation in the Alliford Bay plots since 1999, 2001 was the first year that top-kill or whole-tree mortality could be confirmed. Full recovery of tree crowns has not yet occurred in any study plots and mortality or top-kill of badly-damaged trees may continue for a few more years. Thus final estimates of losses are not yet available. Nonetheless, some minimum estimates can be made. Whole-tree mortality was observed in 3 of the 10 Alliford Bay sites and in 1 of the 2 sites on Graham Island. The percentage of trees with dead tops in our study plots ranged upwards to 70% in 2001 (Table 3). In general, the mean length of dead tops declined in 2001 as recovery proceeded (Table 3). However, as mentioned, most trees with previously observed top-stripping have not fully recovered their original crown height.

The most severe impact of past defoliation was recorded at stand opening number J1065, near MacMillan Creek. This is one of the highest elevation sites and was severely defoliated in 1998 and 1999 (Figs. 2, 3). Observations in this stand may serve as an indication of the levels of mortality and top-kill now present in the 1500 ha of grey (dead tops and/or dead trees) mapped during aerial surveys in 2001 (Fig. 1). This year, 42% of the plot trees are dead. Among survivors, 18% have more than 50% of their crowns stripped completely. Even if these remaining trees survive to recover, their growth and form has been severely compromised. Similar observations were made at King Creek on Graham Island where severe defoliation occurred in 2000. This year, 3 of the 10 tagged trees in this plot had died and 5 of the remaining 7 had dead tops.

Damage to associated conifers

With no current feeding damage , Sitka spruce have started to recover from the defoliation that occurred in 1999. New foliage and lateral shoots assuming dominance were observed at the Alliford Bay sites. Other than a few years loss of increment and the very occasional short dead top, Sitka spruce seems to be recovering from the effects of blackheaded budworm feeding.

Egg sampling and defoliation predictions

Branch samples taken from the 10 Alliford Bay sites in 2000 indicated no defoliation was expected in 2001. As predicted, no defoliation occurred in any of these sites in 2001. Similarly, egg estimates from four sites on central Graham Island in 2000 indicated light or nil defoliation for 2001. No defoliation occurred at these sites in 2001 so no branch sampling was carried out in 2001. Egg samples were collected at four new locations on Moresby Island, and at four new locations on Graham Island, between the Rennel Sound road and Juskatla, in the winter of 2001. Samples from the Moresby Island sites predicted no defoliation in 2001 while those from the most northerly Graham Island sites predicted light defoliation for the 2001 season. These predictions were borne out in 2001. No defoliation was mapped on Moresby Island and on Graham Island there was one small area of light defoliation mapped south of Juskatla, near Marie Lake, and a few small areas of light and one small area of moderate defoliation recorded north west of Juskatla in 2001. No branch samples were taken at any of these sites in 2001. Based on historical patterns, no blackheaded budworm defoliation is expected to occur on the Queen Charlotte Islands in 2002.

Plans for 2002

In 2002, conditions of trees in all Alliford Bay sites will be re-assessed to measure recovery, top kill or tree mortality. This will help to quantify the relationship between severity of defoliation, and impact on regenerating western hemlock, as well as allow us to further determine the relative susceptibility of spaced and unspaced stands (hazard rating).

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